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ABSTRACT

This study, part of a 4-year longitudinal project, examined the possible relationship between persistent otitis media (middle ear disease) in early childhood and speech and language functioning. Subjects were 38 black preschool children between 3 and 7 years of age who, although normal in intellectual and verbal functioning, were identified as at high risk for poor school performance because of socioeconomic and cultural factors. Data were recorded over 2 years regarding occurrence of otitis media (with children screened once a month); speech production accuracy (using the Goldman Fristoe Test of Articulation which also assessed the number of consonants in error); and language form, content, and use (using the Systematic Analysis of Language Transcripts computer program). Results of analyses showed no relationship between incidence of otitis media and number of consonants in error on the articulation test. The error and process rate for the subjects appeared to be within the range of normally developing children. The data did suggest that children with more otitis media in their history had less intelligible conversational speech. It is concluded that the results support only a slight otitis media speech relationship for high risk disadvantaged children. (CB)

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The Effects of Otitis Media on Speech and Language

Grant Number G008302191

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The Effects of Otitis Media on Speech and Language

During the past decade, several studies have identified an association between otitis media with effusion (OME) in early childhood and later speech disorders (Holm & Kunze, 1969; Klein, 1982; Menyuk, 1979; Needleman, 1977; Northern & Downs, 1978; Shriberg & Smith, 1983; Zinkus & Gottlieb, 1980). These studies have found both more speech errors (Holm & Kunze, 1969; Needleman, 1977) and different error patterns (Shriberg & Smith, 1983) in children with a history of otitis media as compared to children without such a history. It has been hypothesized that the fluctuating hearing loss associated with OME during the language formative years is responsible for these speech problems. Although several studies support a linkage between early OME and later speech problems, the issue still remains controversial Menyuk, 1979, 1980; Paradise, 1981; McWilliams, 1983; Ventry, 1983). The purpose of this study was to examine prospectively the relationship between OME during the first three years of life and speech performance between the ages of three and seven years in a group of children whose psychoeducational and medical histories had been monitored since early infancy.

Speech production. The relationship between otitis media and speech production was investigated in three studies (Holm & Kunze, 1969; Needleman, 1977; Shriberg & Smith, 1983). Holm and Kunze (1969) compared the speech performance of 16 children 5 to 9 years old recruited from an ear, nose, and throat clinic who had histories of chronic otitis media with 16 children seen in a hospital with no such histories. They reported significant differences in errors on the Templin Darley Screening Tests of Articulation. Similarly, Needleman (1977) used the Templin Darley Screening Tests of Articulation to compare the articulation of one group of 20 children age 3 through 8 with a

history of otitis media and a group without such a history. Needleman (1977) found that the same sounds were misarticulated in both groups, but that the otitis media group misarticulated these sounds more often. Shriberg and Smith (1983) compared retrospectively the conversational speech samples of two groups of 11 speech disordered children age 3 1/2 to 6 with and without histories of otitis media. The researchers reported qualitative differences in speech patterns of children with recurrent OME. Two distinct phonological patterns were common in the otitis group: (a) initial consonants were deleted or substituted by [h] or glottal stop and (b) nasal sounds were either replaced by another nasal consonant or stop, denasalized, or preceded or followed by an epenthic stop.

Language comprehension and production. In contrast to the studies of speech development, an increasingly large number of studies have investigated the effects of otitis media on language. In one of the earliest studies, Holm and Kunze (1969) compared the language performance of 16 five to nine year old children with and without histories of otitis media. They found significant differences in 1) receptive vocabulary on the Peabody Picture Vocabulary Test, 2) verbal language development on the Meecham Verbal Language Development Scale, and 3) production of verbal responses on the Illinois Test of Psycholinguistic Abilities. Several retrospective studies (Benett, Kuuska, & Sherman, 1980; Gottleib, Zinkus, & Thompson, 1979; Masters & Marsh, 1978) found higher incidence of OME in children with established educational, language, and learning problems. These associations between OME and subsequent language delays during the preschool and early school age years were also found in several prospective studies (Lewis, 1976; Needleman, 1977; Sak & Ruben, 1981; Friel-Patti, et al., 1982; Silva, Kirkland, Simpson,

Stewart, & Williams, 1983). Receptive and expressive language delays occurred as measured by the Illinois Test of Psycholinguistic Abilities, Peabody Picture Vocabulary Test and Sequenced Inventory of Communicative Disorders. A recent study, however, by Allen and Robinson (1984) did not find an association between OME and later language performance.

Weaknesses of Previous Studies

The studies linking OME to subsequent speech and language problems must be considered inconclusive because of limitations of research design (Menyuk, 1979, 1980; Paradise, 1981; McWilliams, 1983; Ventry, 1980). Most studies have been retrospective of clinic patients with either a history of OME or speech and language problems. OME was documented by a review of previous medical records or by parent report. Thus, the OME speech relationship is presently unclear. Prospective longitudinal studies are needed to determine the relationship between persistent OME during early childhood and later speech and language functioning.

METHOD

Children

The children studied attended the Frank Porter Graham Child Development Center and were part of a longitudinal research project. All children were identified at birth as biologically normal and classified as at high risk for poor school performance because of socioeconomic and cultural factors. This high risk classification was based on a risk index which included measures of family income, maternal intelligence, parental education, and family stability (Ramey & Smith, 1977). The children entered the day care program of the Center at approximately 2 months of age in yearly cohorts of 12 to 14 individuals. They attended the Center five days a week, 50 weeks a year until

age 5, when they began school. Their developmental progress continued to be monitored through elementary school.

The reported study is part of a four year longitudinal project. The data presented here is derived from the first two years of data collection. Thirty-eight children ranging in age from three to seven participated in the study. All children were black. Twenty-six were male and 12 were female. The subjects' mean intelligence score on the Stanford Binet Intelligence Scale at 48 months was 102; their mean score on the McCarthy Verbal scale at 42 months was 53.4. These scores indicate both normal intellectual and verbal functioning.

Occurrence of OME

During the children's attendance at the Center, they received complete medical care, which was provided by a medical staff of two pediatricians and two nurse practitioners. Physical examinations were performed when the medical staff, teachers, or parents reported illness symptoms. The diagnosis of OME was established using pneumatic otoscopy and tympanometry. The middle ear status of the children was monitored routinely once a month by otoscopy and tympanometry. Otoscopy and tympanometry were performed on days 1 and 4, following the diagnosis of all respiratory illnesses and at two week intervals until the child was well and tympanometry returned to normal. Medical data, including illness history, physical findings (e.g., tympanic membrane mobility and appearance) diagnosis, and duration of illness were recorded on computer forms. Duration of each episode of unilateral OME (left or right OME) and each episode of bilateral OME (left and right OME) were recorded.

Speech Assessment

The accuracy of speech production was assessed beginning at age three using the Goldman Fristoe Test of Articulation. To increase the number of

blends, six words testing blends were added to the 36 words on the Goldman Fristoe. Intelligibility of speech was assessed during a 25 minute conversational speech sample using a "7" point rating scale developed by the investigators. A rating of "1" indicated speech is completely intelligible and "7" completely unintelligible. The measures are shown in the Appendix.

Children's speech were tested if they passed a hearing screening at 15 dB for 1000 and 2000 Hz and at 20dB for 500 and 4000 Hz and (2) had a Type A or C tympanogram. Children first named pictures on the Goldman Fristoe Test of Articulation and then participated in the conversational speech sample. Two graduate research assistants collected the data under the supervision of the first author. Responses on the articulation test were coded live using the narrow transcription symbols of Shriberg and Kent (1981). For 25% of the sample, two examiners evaluated the child's responses. Interexaminer agreement for consonants coded was 85%. Intelligibility was rated from audiotapes using the middle 10 minutes of the spontaneous speech sample. For 15% of the sample, two examiners rated the same tape. Inter-examiner agreement was 83%.

All phonemes in words on the articulation test were scored for the number of consonants in error (CER) following guidelines similar to those Shriberg and Kwiatkowski (1982) used to compute percentage of consonants correct. For example, on the word /telefon/ a child could receive a maximum score of four errors. For the 42 words tested, there were 152 consonants examined for potential errors. These words were then coded for phonological processes following Ingram's (1981) processes. Black dialect patterns (e.g., f for th in final position) as defined by Williams and Wolfram, (1977) were not scored as errors.

Language Assessment

The spontaneous speech samples elicited during speech testing were coded for language form (syntax), content (semantics) and use (praymatics) using a computer program Systematic Analysis of Language Transcrips (SALT) (Miller and Chapman, 1983). These analyses are presently in process.

RESULTS

Speech Outcomes

Table 1 shows by age group the mean frequency and standard deviation for consonants in error and selected phonological processes on the Goldman Fristoe Test of Articulation and mean frequency for ratings of speech intelligibility on the conversational speech sample. These measures are from two years of data collection where thirteen children were tested one time and 25 twice in consecutive years. There is a marked decrease in number of consonants in errors (CER) (from 23 to 11) between the ayes of three and four and a small decrease (from 9 to 5) between ages of five and six. Speech intelligibility increases between the ages of 3 and 4 and remains somewhat stable between 4 and 7 years of aye. The phonological processes: deletion of final consonants, cluster reduction, depalatization, and liquid gliding, decreased between the ages of three and four and then the scores tended to become more stable. Stopping occurred infrequently across all ages and did not change until aye 7. Other phonological processes including velar fronting, unstressed syllable deletion, reduplication, assimilation, and prevocalic voicing rarely occurred. This change in phonological process usage and infrequent occurrence of processes after age four is according to Ingram (1976), characteristic of normal phonological development. Thus, for this sample of disadvantaged

children, their error and process rate appears to be within the range of normally developing children.

Since we were interested in whether there were long term effects of OME on speech performance and we had found a marked change in phonological development between the ages of three and four, we selected speech outcome measures between the ages of four and seven. We chose consonants in error (CER) on the Goldman Fristoe Test of Articulation and rating of speech intelligibility on the conversational speech sample, because these two variables had a reasonable range of outcome, making it possible to detect a differential influence of OME. Phonological processes which occurred infrequently and had a limited range of occurrence could not be examined for their relationship to OME. We therefore analyzed the OME speech relationship on 35 of the original 38 children during test sessions which occurred between the ages of four and seven. For children tested twice between the ages four and seven, only their first year of data was entered into the analyses.

Otitis Media Experience

From the children's computerized records, the total number of days of left OME, right OME, and bilateral OME were computed. Two scores were calculated: (1) the total duration of either bilateral or unilateral OME during the first three years of life and (2) the total duration of bilateral OME only. Since these two scores were highly correlated (Spearman rank correlation of .94), only the total duration of bilateral or unilateral OME was used for the analyses (Total OME). Figure 1 shows the distribution of children by OME experience in the first three years of life. The duration of total OME during the first three years of life ranged from 8 to 931 days. The average number of days of OME was 251. The median was 196. The distribution is skewed and appears bimodal.

Otitis Media Speech Relationship

Figure 2 shows the plot of the relationship between OME and CER. To examine this relationship, CER from the Goldman Fristoe Test of Articulation is plotted along with the number of days of OME in the first three years of life. The plot suggests that OME and CER are not linearly correlated which is confirmed by the Spearman Rank correlations of .19 that was not statistically significant. Data in Figure 3 shows the plot of the relationship between OME history and scores of intelligibility. Although a relationship is not readily apparent visually, a Spearman Rank correlation revealed a significant correlation ($R=.40$ $p<.01$) between amount of time with OME and speech intelligibility. The more OME a child had the higher their intelligibility score was which means they were less intelligible. Table 2 shows these rank order correlations for OME and the speech outcomes.

As a second approach to examining the OME speech relationship, the data were divided into a low OME group (0-195 days) and a high OME group (195-931 days) using the median of 195 days of OME during the first three years of life. An analysis of variance was used to examine the relationship between OME group and CER and intelligibility scores. Table 3 shows that as before the OME groups did not differ with respect to the mean frequency of CER but did significantly differ for intelligibility ($F=6.69$; $df=1.22$ $p<.01$). Table 4 shows these mean group differences where children were less intelligible in the group with more OME experience. The difference like the correlational analysis suggests that OME may be related to speech intelligibility. However, it remained possible that age was a confounding factor.

Table 5 shows the analysis of variance including age and OME as predictors. The sample was divided by age into three groups--4 year olds, 5 and 6 year olds, and 7 year olds. These results show that when age effects are partialed out, OME is no longer significant ($F=3.36$; $df=1,57$; $p=.08$). This may be a problem of power due to the small sample size. Age appeared to explain some of the effects of OME but not all of the effects.

Discussion

The results in this study showed no relationship between OME experience and number of consonants in error on an articulation test. The data suggest a trend in the relationship between intelligibility of conversational speech and previous OME history. Our study certainly does not support a strong conclusion of an OME speech relationship for high risk disadvantaged children. We will continue to monitor the speech of these and additional children over the next two years. We anticipate that increasing the number of subjects will give us more power and allow us to use repeated measures techniques to examine the OME speech relationship.

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Table 1: Frequency of Speech Outcome Measure by Age*

Speech Outcome (Total Number Possible)		Age 3 (N=11)	4 (n=12)	5 (n=15)	6 (n=12)	7 (n=13)
A. Speech Intelligibility (1-7)	Mean	4.00	2.75	2.40	2.17	2.00
	SD	0.89	0.97	0.51	0.58	0.41
B. Consonants in Error (152)	Mean	23.09	10.75	8.87	5.17	4.77
	SD	11.26	8.34	7.17	9.61	4.28
C. Phonological Processes						
1. Deletion of Final Consonants (39)	Mean	2.55	1.33	0.93	0.75	0.31
	SD	2.07	1.44	1.79	2.60	0.48
2. Consonant Cluster Reduction (39)	Mean	6.36	1.08	1.27	0.75	0.69
	SD	3.75	1.00	1.79	2.01	0.95
3. Depalatization (9)	Mean	1.27	0.25	0.27	0.25	0.08
	SD	1.35	0.87	0.46	0.37	0.28
4. Stopping (35)	Mean	0.27	0.33	0.33	0.25	0.0
	SD	0.65	0.49	0.62	0.87	0.28
5. Liquid Gliding (13)	Mean	0.91	0.42	0.40	0.33	0.08
	SD	1.04	0.90	0.74	0.89	0.28

*Note: This is the number of tests administered at each age.

Figure 1: Distribution of Children by Otitis Media Experience

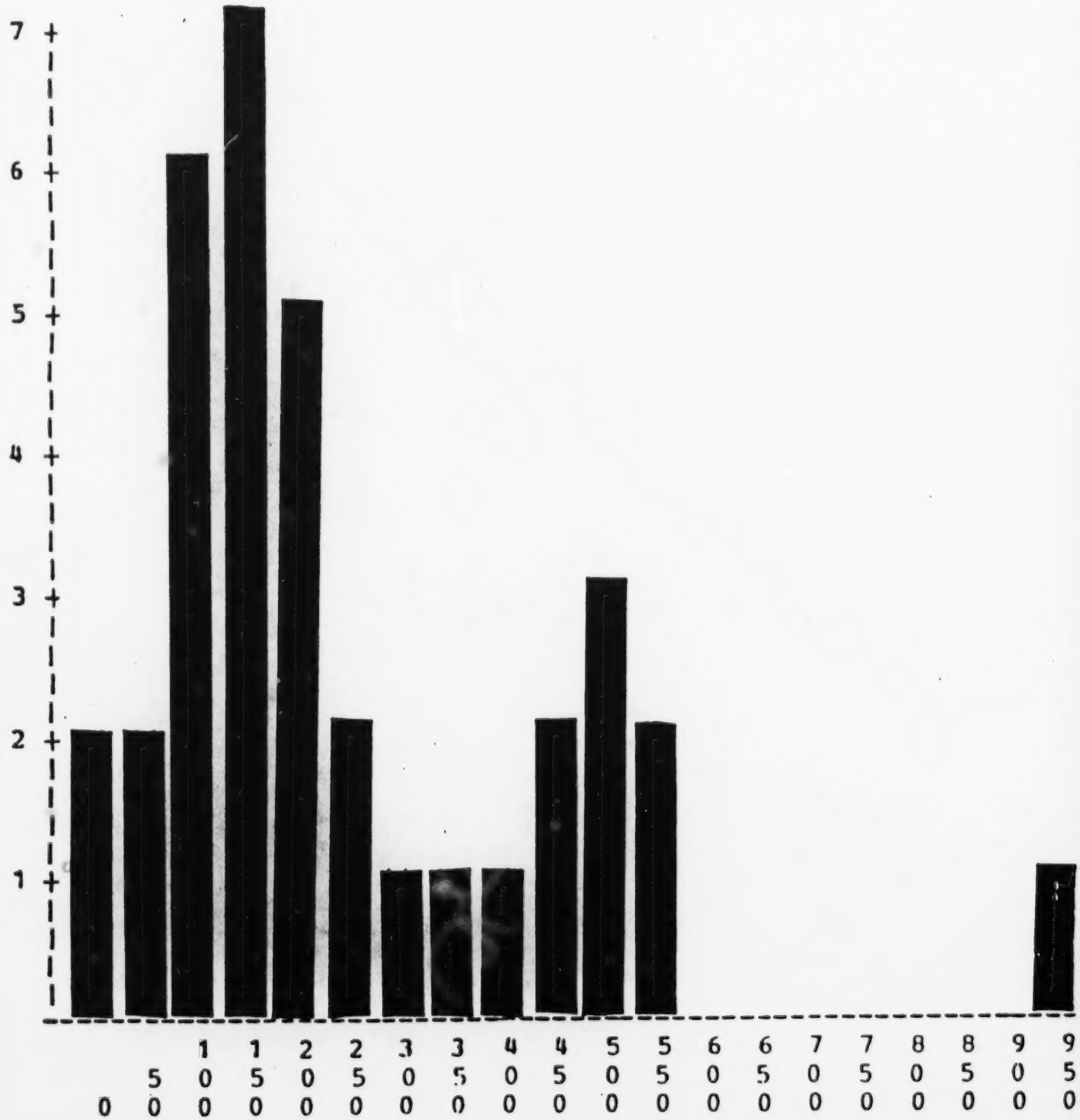

Table 2: Rank Order Correlations between OME and Speech Variables

	Duration of OME	Consonants in Error	Intelligibility
Duration of OME			
Consonants in Error	.19		
Intelligibility	.40 $p<.01$	.61 $p<.001$	

Figure 2: Plots of Rank Order Correlations Between OME and Speech Intelligibility

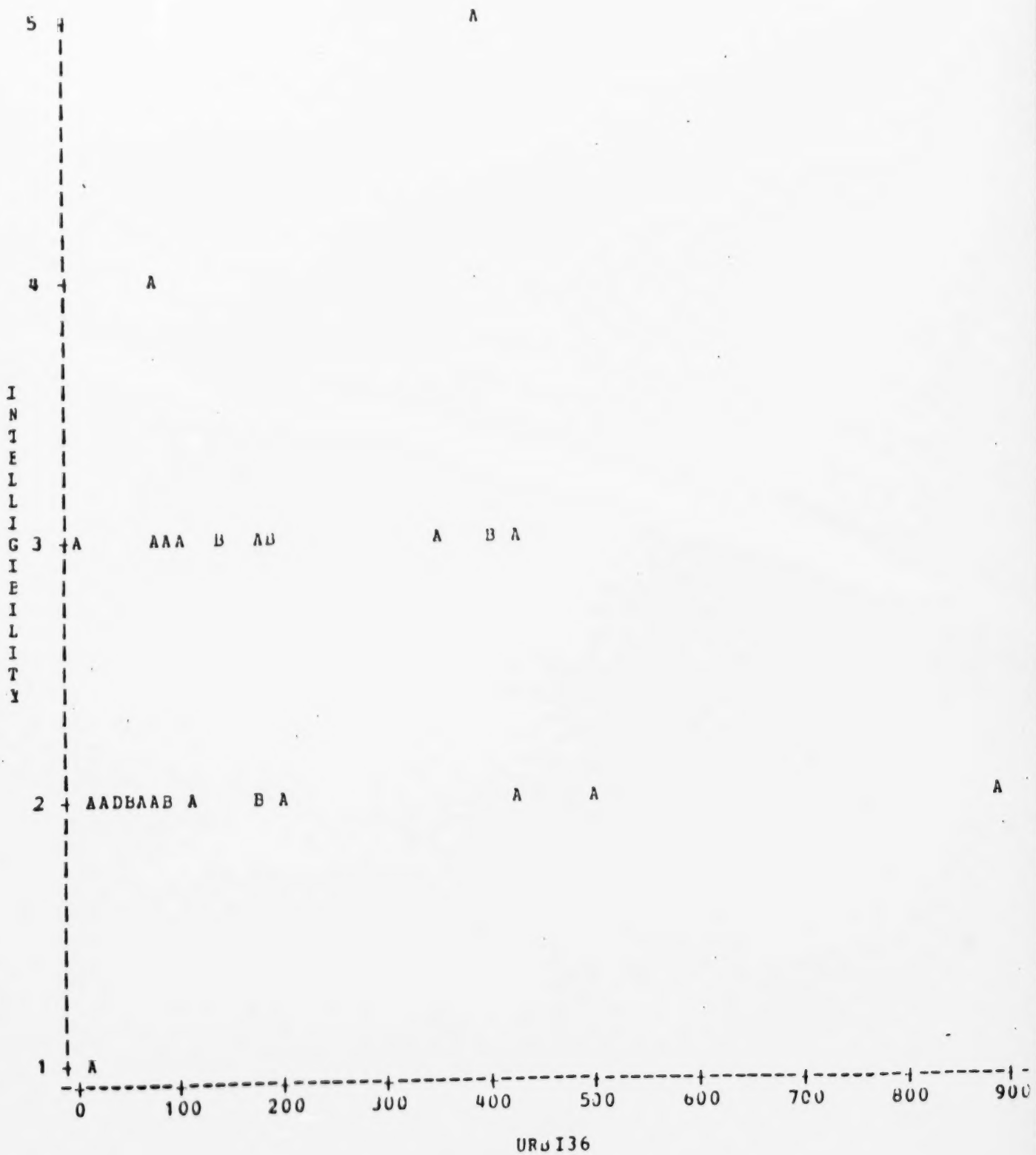

Figure 3: Plots of Rank Order Correlation Between DUR and Consonants in Error

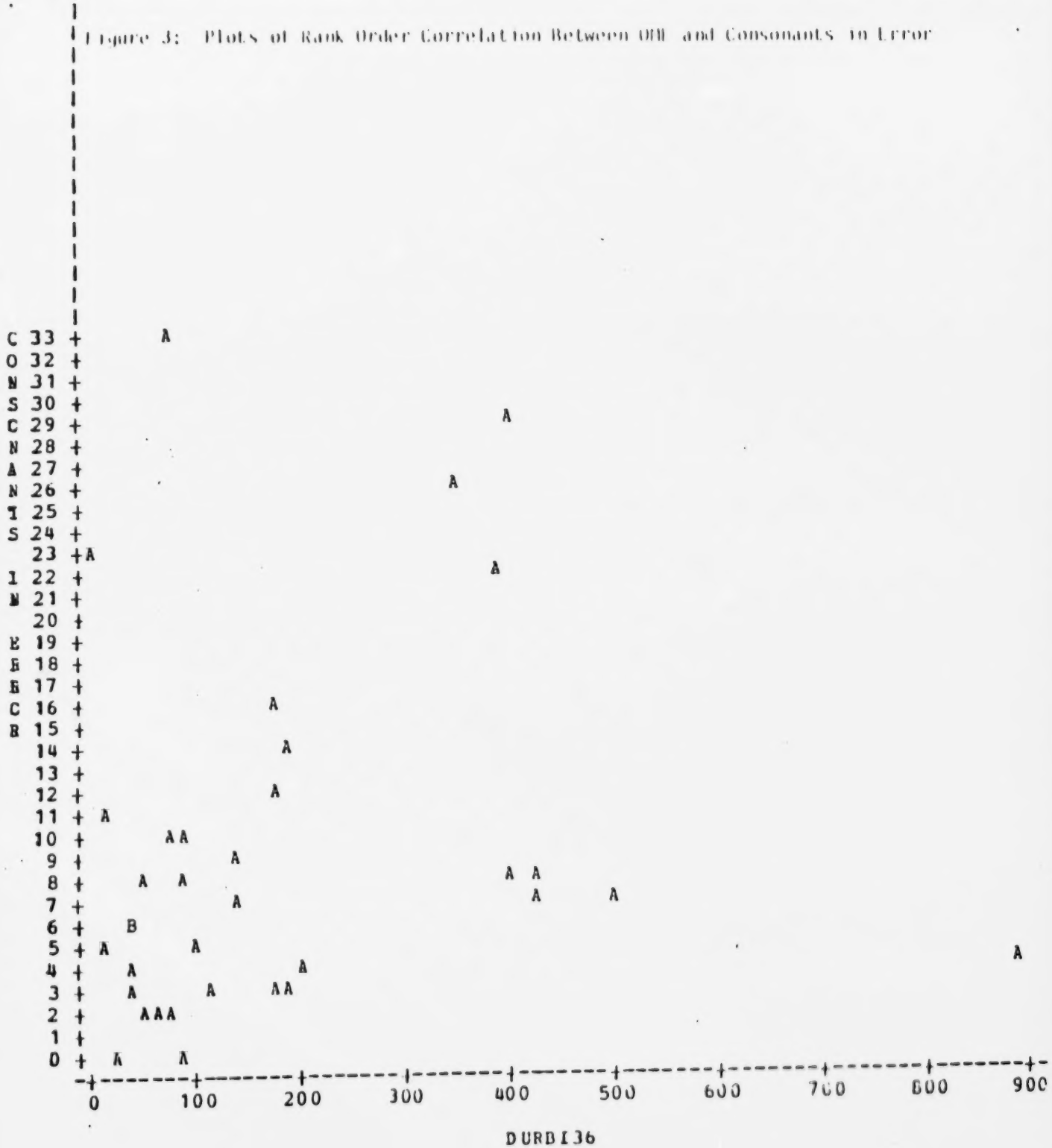

Table 3: Analysis of Variance for OME Effect on Intelligibility and Consonants in Error

Variable	Source	df	SS	F	p
Intelligibility	OME	1	3.16	6.69	.01
	Error	33	15.58		
	Total	34	18.74		
Consonants in Error	OME	1	86.05	1.28	.27
	Error	33	226.24		
	Total	34	312.29		

Table 4: Frequency of Means for Speech Outcome by OME Duration

Speech Outcomes (Total Number Possible)	Duration of OME: Low 195 Days of OME (n=17)	Duration of OME: High 196-931 days of OME (n=18)
1. Intelligibility (1-7 rating)		
Mean	2.18	2.78
Standard Deviation	0.53	0.81
2. Consonants in Error (152)		
Mean	7.53	10.67
Standard Deviation	8.25	7.91

Table 5: Analysis of Variance for OME Effect on Intelligibility Partialing Out Age

Source	df	SS	F	p
OME	1	1.57	3.36	.08
Age	2	1.21	1.30	.29
OME*Age	2	1.26	.27	.76
Error	29	13.51		
Total	34	16.55		

Table 6: Frequency of Speech Outcomes by OME Group

Speech Outcome (Total Number Possible)		Duration of OME: Low 0-195 Days of OME	Duration of OME: High 196-931 days of OME
		(n=17)	(n=18)
A. Intelligibility (1-7)	Mean	2.18	2.78
	SD	.53	.81
B. Consonants in Error (152)	Mean	7.53	10.67
	SD	8.25	7.91
C. Phonological Processes			
1. Deletion of Final Consonants (39)	Mean	1.18	1.17
	SD	2.30	1.76
2. Cluster Reduction (20)	Mean	1.18	1.28
	SD	1.70	1.67
3. Depalatization (9)	Mean	0.22	0.35
	SD	0.73	0.79
4. Stopping (35)	Mean	0.22	0.47
	SD	0.73	0.62
5. Liquid Gliding (13)	Mean	0.29	0.56
	SD	0.59	1.04
6. Unstressed Syallable Deletion (24)	Mean	0.12	0.11
	SD	0.33	0.47
7. Reduplication (25)	Mean	0.0	0.0
	SD	0.0	0.0
8. Velar Fronting (12)	Mean	0.00	0.00
	SD	0.00	0.00
9. Assimilation (35)	Mean	0.0	0.06
	SD	0.0	0.24
10. Prevocalic Voicing (20)	Mean	0.0	0.0
	SD	0.0	0.0

APPENDIX

GOLDMAN FRISTOE TEST OF ARTICULATION

NAME _____ DATE _____ ID _____ E_1 _____ E_2 _____

IDENTIFIES PICTURES CORRECTLY:

1 Always 2 Often 3 Sometimes 4 Infrequently 5 Never

1. _____ (haʊs)
2. _____ (tɨlɨfon)
3. _____ (kʌp)
4. _____ (gʌn)
5. _____ (naɪf)
6. _____ (wɪndo)
7a. _____ (wægʌn)
7b. _____ (wil)
8. _____ (ʃɪkɪn)
9. _____ (zɪpɚ)
10. _____ (sɪz ɚz)
11a. _____ (dʌk)
11b. _____ (jɛlo)
12. _____ (vækjum)
13. _____ (mæʃɪz)
14. _____ (læmp)
15. _____ (ʃʌvəl)
16. _____ (kar)
17. _____ (ræbɪt)
18. _____ (fɪʃɪŋ)
19. _____ (bor)
20. _____ (ʃʊrʃ)
21. _____ (fɛθɚ)
22a. _____ (pɛnsɪlz)
22b. _____ (ʒɪrs) (ʒæt)
23a. _____ (kæræt)
23b. _____ (ɔrɪnʤ)

24a. _____ (bæθtʌb)
24b. _____ (bæθ)
25a. _____ (θʌm)
25b. _____ (fɪŋgɚ)
25c. _____ (rɪŋ)
26. _____ (ʤʌmpɪŋ)
27. _____ (pʌʤæmʌz)
28a. _____ (plerɪn)
28b _____ (blu)
29. _____ (brʌʃ)
30. _____ (drʌm)
31. _____ (flæg)
32. _____ (sæntɔklaʊz
33. _____ (krɪsmʌstri)
34. _____ (skwɪrl)
35a. _____ (slipɪŋ)
35b. _____ (bɛd)
36. _____ (stov)
37. _____ (spun)
38. _____ (skaɪ)
39. _____ (prɛzɪnt)
40. _____ (grin)
41. _____ (smok)
42. _____ (glæs)

FROM SENTENCE IMITATION TEST

16. _____
18. _____
19.

A. INTELLIGIBILITY

1	NORMAL	Speech is completely intelligible.
2	NORMAL/MILD	Speech occasionally has slight errors.
3	MILD	Speech frequently has slight errors.
4	MILD/MODERATE	Speech is noticably in error, but major content is intelligible.
5	MODERATE	Speech is noticeably in error, but is intelligible only with careful listening.
6	MODERATE/severe	Speech is unintelligible most of the time.
7	SEVERE	Speech is completely unintelligible.

B. LOUDNESS

-2	-1	0	1	2
Very Loud	Loud	Normal	Soft	Very Soft

C. PITCH

-2	-1	0	1	2
Very High	High	Normal	Low	Very Low

D. NASALITY

-2	-1	0	1	2
Very Hypernasal	Nasal	Normal	Denasal	Very Denasal

E. HOARSENESS

-2	-1	0
Very Hoarse	Hoarse	Normal

F. BREATHINESS

-2	-1	0
Very Breathy	Breathy	Normal

G. HARSHNESS

-2	-1	0
Very Harsh	Harsh	Normal

H. RATE

-2	-1	0	1	2
Very Fast	Fast	Normal	Slow	Very Slow

I. STRESS

-1	0
Inappropriate	Appropriate

J. FLUENCY

-2	-1	0
Noticeable repetitions	Occasional repetitions	Normal

BEST COPY AVAILABLE